Addendum to the

Nebraska Mathematics/Science Frameworks

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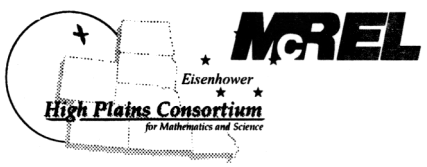

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Assessment

A look into a classroom may reveal a teacher teaching to the test, students interested in learning what will be on the test, and administrators gauging progress from test results. In the past, testing has been the primary means of assessment.

Test results serve a variety of functions including student ranking and placement. Often instruction has been designed to match the test. Educators must broaden their concept of assessment to go beyond testing, to include thought-provoking questions and problems so that assessment becomes a part of the instructional process.

Traditionally, instruction and assessment have been separate entities. Assessment must be an integral part of instruction and learning so that it is used as a tool to influence instruction. This requires developing and implementing assessment strategies that measure students' performance on tasks that emphasize the ability to think critically, to demonstrate a real understanding of concepts studied, and to apply what one knows to the kinds of complex problems encountered in life.

The national mathematics standards (National Council of Teachers of Mathematics) and national science standards (National Research Council) focus on conceptual understandings and analytical skills. This change in emphasis requires mathematics and science educators to examine current assessment practices. Assessment strategies need to be aligned with the vision of mathematics/science that engages all students in educational experiences that teach the nature and process of mathematics/science as well as the content. The unique nature of mathematics and science, especially hands-on experiences, requires a variety of assessment strategies.

What is Assessment?

Assessment is a process used to monitor skills, check for depth of knowledge and understanding, and modify instruction. Discovering where students are and where they need to go is the purpose of a continuous, multidimensional assessment procedure. Assessment gives diagnostic information about what students have learned and can be used to improve educational programs. To be truly effective, assessment results must be communicated to students, parents, and other educators. Students need to receive assessment feedback and be given time and support to improve their own learning. The process of using assessment data to make judgments is called evaluation.

Types of Assessment Strategies

Individual differences in students and in the way they learn mathematics/science requires assessing in a wide variety of ways to ensure that teachers accurately determine what the student is learning. Traditional modes of assessment such as pen/pencil tests may be used. Alternative means of assessment include authentic assessment and performance assessment.

Performance assessment strategy requires students to complete a task, create a product, or construct a response that demonstrates their knowledge of a skill, process, or concept. Rubrics or scoring guides provide students and teachers criteria with which to judge a performance assessment. Rubrics clarify for both students and teachers how process skills are being measured and help monitor skill development. See appendix for sample rubrics to assess the mathematics/science process skills of learning.

The authentic assessment strategy uses real-life situations and problems that are relevant to life outside of school. Teachers need to offer students "real" problems where students organize data, draw conclusions, and present possible solutions. These open-ended investigations may generate a number of acceptable solutions. This assessment strategy provides students with the opportunity to demonstrate conceptual understandings of the big ideas, to use process skills and tools, and to apply their understanding of these big ideas to solve new problems.

Paper/pencil assessment includes traditional end-of-the-unit/chapter tests, teacher-made tests, norm-referenced tests, and criterion-referenced tests. The criterion-referenced assessment strategies are designed to reveal what a student knows, understands, or can do in relation to specific criteria. Criterion-referenced assessments are required by the State of Nebraska to determine acquisition of competencies in reading, writing, and mathematics beginning in the fifth grade. A norm-referenced test compares a student's knowledge and skills to a group norm. Nebraska requires a norm-referenced test at least once at the upper elementary, middle school, and high school levels. Paper/pencil assessment provides important feedback useful in monitoring students' continuous progress.

Emerging Ideas in Assessment Techniques

Students should know what they are to learn and how they will be expected to demonstrate that learning. Communicating goals and objectives provides students with reasons to learn. Specifying expectations and establishing criteria allow students to see where they are going and how they will know when they have gotten there. Adding criteria to teacher and student behaviors, such as communication, observation, and representation, have resulted in excellent assessment techniques.

Students' personal communication can give information about what they are thinking and understanding. Written tests offer one avenue for teachers to check for knowledge and understanding. However, providing problems and merely determining whether the answer is correct is insufficient. Teachers must assess the students' levels of understanding by looking at the processes and strategies used to find the correct solution. These processes and strategies can be shown in students' journals or learning logs. Journals or learning logs give students a chance to share their "Aha!" discoveries and understandings.

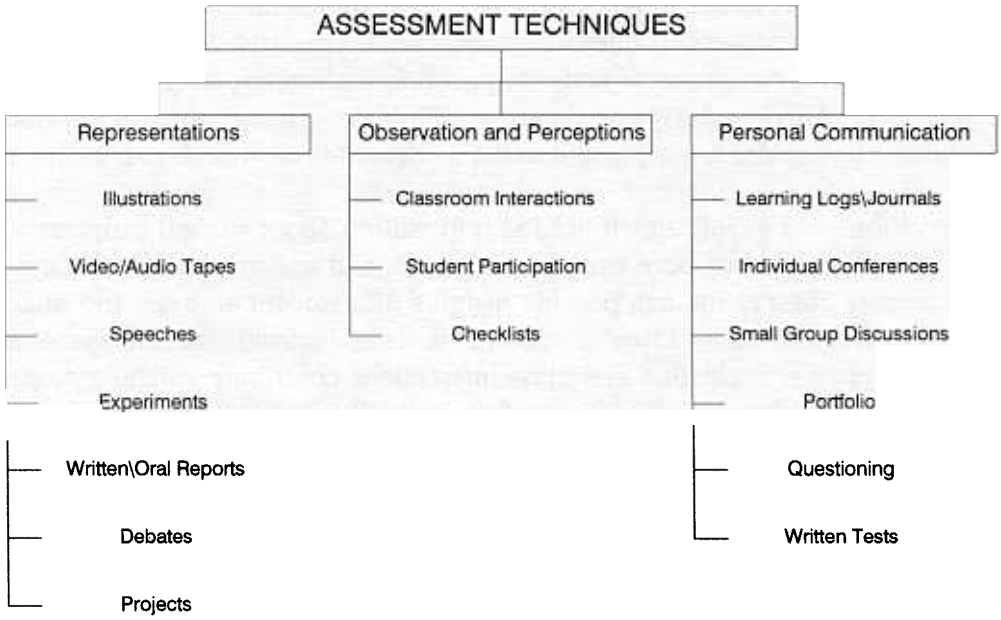
There are several other techniques which promote student communication and self-assessment. For instance, individual conferences allow time for students to ask questions that they may not ask in large group situations. Cooperative learning and small group discussions provide

an avenue for personal communication, peer teaching, and assessing. Portfolios present an opportunity for the collecting of and reflecting on a student's work as well as enabling the student to make decisions about self-assessment. Communication between teacher and students in the form of open-ended questioning enables teachers to determine if students understand the problem, can organize and interpret information, are able to make generalizations, and clarify and express their own thinking. Thought-provoking questions challenge students to explore concepts and assist students to reach high expectations.

Teacher observations can supply much-needed information about student progress. In the past, teacher observations have been primarily informal and undocumented. When documented, teacher observation can provide insights into student abilities and understandings and help focus instruction. Checklists of specific skills and knowledge and systematic observations of student participation and class interactions contribute valuable assessment information. Rubrics which specify criteria of desired behaviors help to formalize the checklist.

There are many opportunities for students to demonstrate their knowledge and skills. These include experiments, written and oral reports, illustrations and graphing of information, debates or skits to portray information, projects, or multimedia presentations. These representation opportunities enable students to learn by doing, promote inquiry and problem solving, accommodate diverse student learning styles, stimulate student interest, and encourage creativity and inventiveness.

The alignment of curriculum, instruction, and assessment enhances learning for all students. The best assessment techniques are ones that not only monitor but enhance learning and instruction. The Nebraska Mathematics/Science Framework Project recommends that a variety of assessment techniques be used. Variations in assessments leads to a broader, more complete picture of the student's abilities and understandings. The following graphic organizer illustrates a variety of assessment techniques. Diverse assessment techniques can help teachers to understand a student's progress and design opportunities for future growth.



Nebraska Mathematics/Science Frameworks Beliefs about Assessment

The Nebraska Mathematics/Science Frameworks believes that assessment for all students should be:

- an integral, enriching part of learning and instruction.
- reflective of instructional goals.
- student-centered.
- considerate of individual needs and cultural influences.
- motivating, consistent, and non-threatening.
- offering multiple opportunities for success.
- collaborative.
- aimed toward the ultimate goal of self-assessment.

There are many valuable assessment techniques to measure student learning. A variety of techniques are exemplified in the mathematics/science instructional models found on pages L – 18 — L – 64.

Connections

Connections must be made within mathematics and within science as well as across all disciplines. The following concept webs illustrate how a hands-on, student-centered activity can be used to connect the five core subjects included in Nebraska Department of Education Rule 10, process skills of learning, conceptual understandings, and the community.

The core subject areas of mathematics, science, social sciences, and language arts were selected from Nebraska Rule 10. For accreditation purposes, these core subject areas must be part of the instructional program at both the elementary and secondary levels.

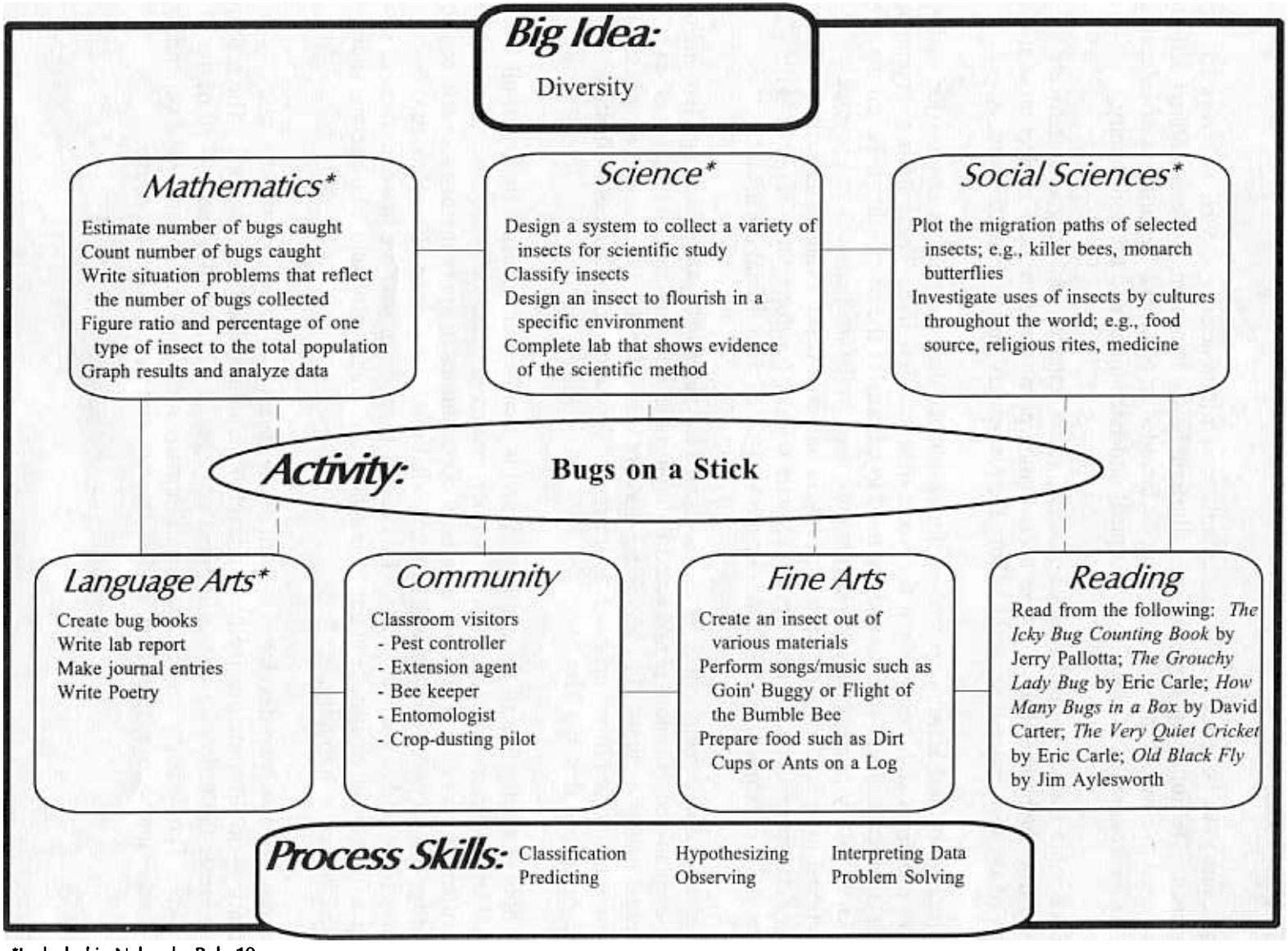
The process skills of learning, promoted throughout the document, serve as tools for students to solve problems and inquire about the world in which they live. These skills are common to both mathematics and science and are used to emphasize the connection between the two disciplines. Many process skills of learning are used in the mathematics and science instructional models. Teachers need to focus on one or two skills during an activity. This provides the opportunity for teachers to facilitate student development of targeted skills. The process skills of learning are defined on page VIII-IX of the original document.

Throughout the document, concepts are developed in great depth while facts and terminology are de-emphasized. Content is addressed through student construction of "big ideas" or conceptual understandings. In creating the concept maps, the activity was the focus used to generate a multidisciplinary approach to learning. This approach enhances students' ability to fully comprehend the "big idea."

The school is a reflection of the community and is a collaborative responsibility of all stakeholders. The community is one of the best resources to help all students make connections to the real-world. Students need opportunities to apply mathematic and science knowledge and to make connections between what they learn in the classroom, in their everyday lives, and in the workplace. This results in students who are more motivated, who exhibit a more positive attitude about their school and community, and who become more involved in their community.

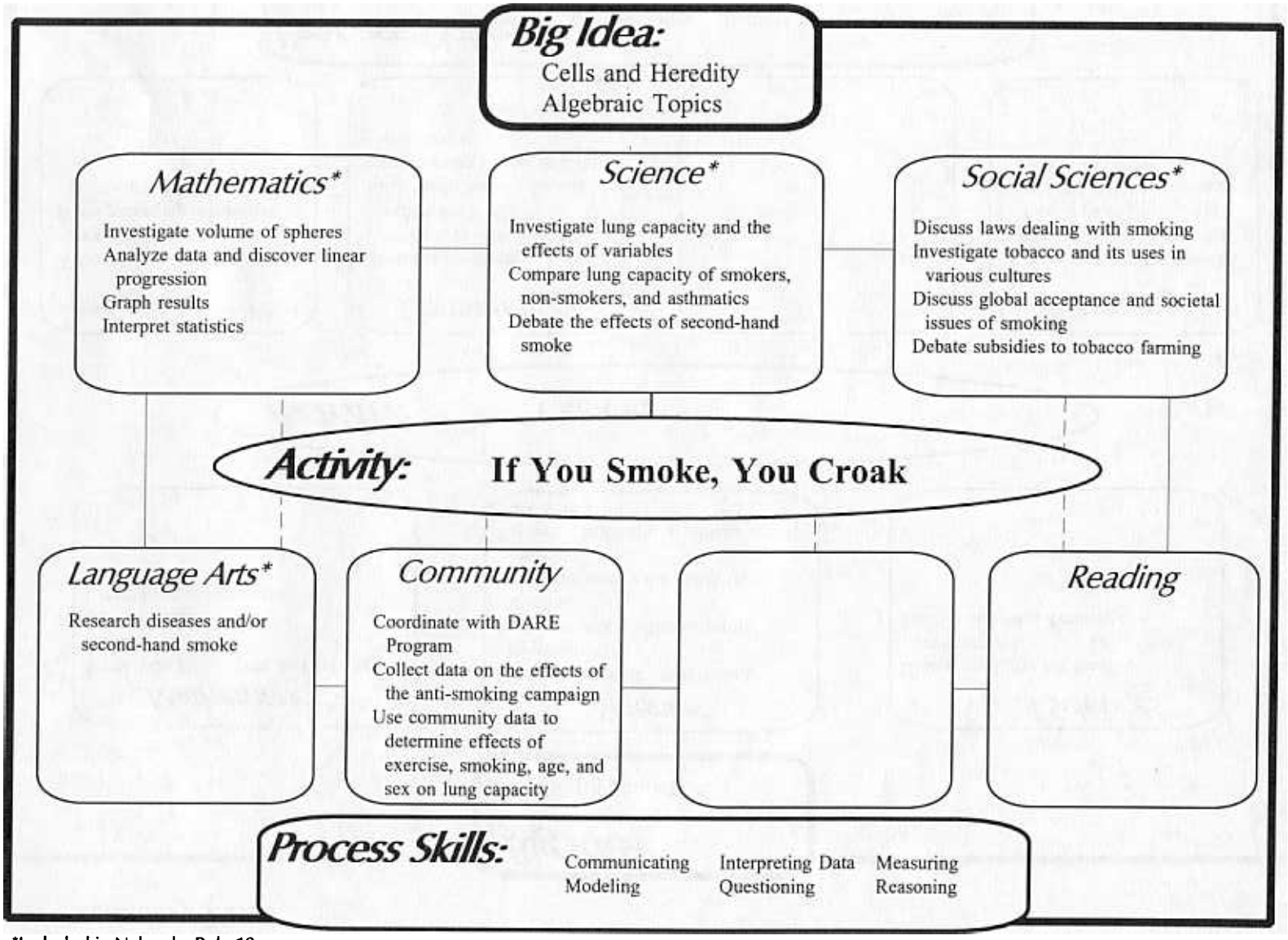
A concept web has been developed at each of the levels — elementary, middle, and secondary — to illustrate one method to develop multidisciplinary connections. The activities used to create the following webs are found on pages L – 27, L – 47, and L – 59 of the addendum. The webbing process can result in many individual and unique webs depending upon teacher knowledge, resources, student interest, and instructional objective.

Concept Web *Elementary Level*



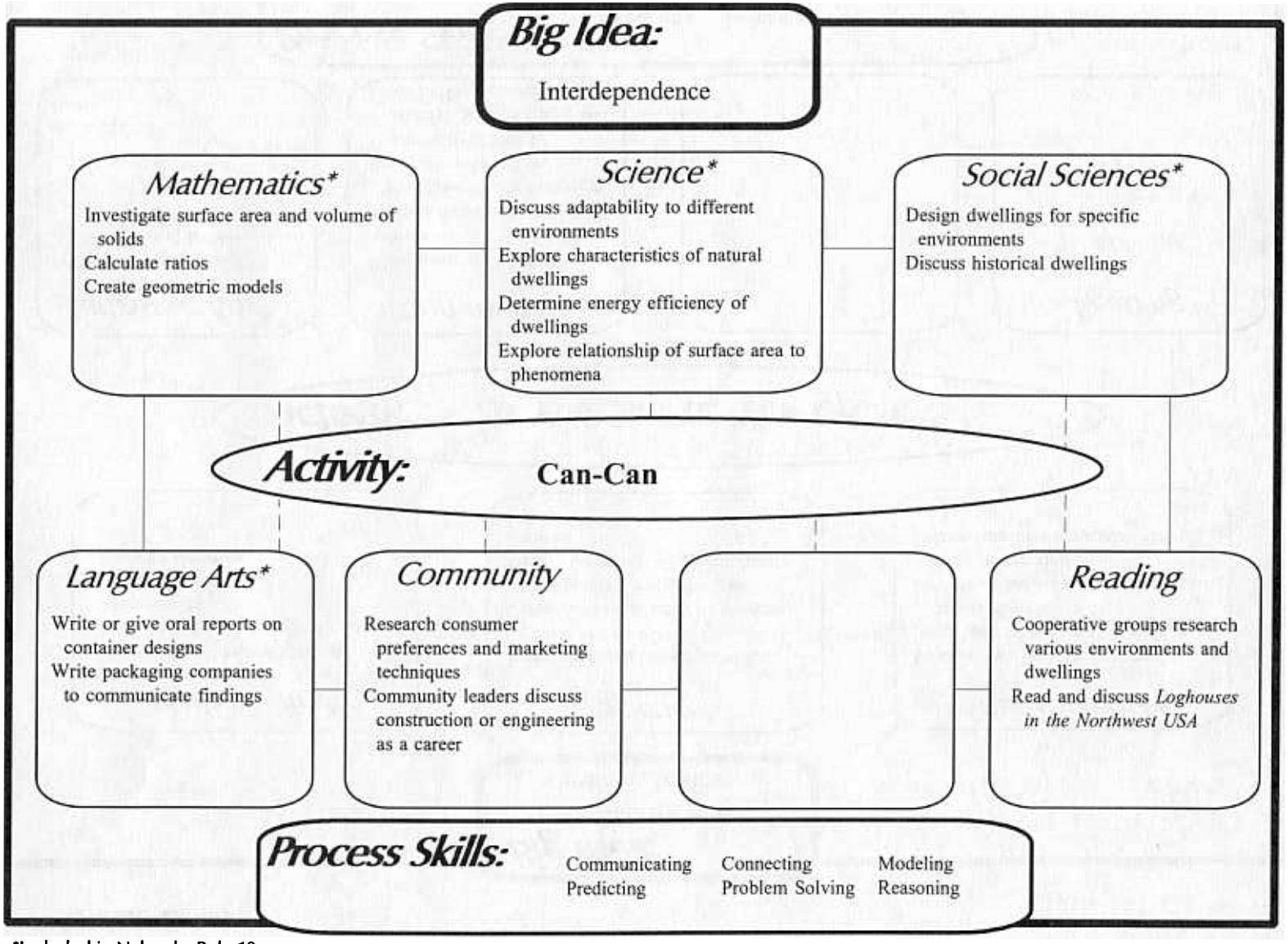
*Included in Nebraska Rule 10

Concept Web ***Middle Level***



*Included in Nebraska Rule 10

Concept Web — Secondary Level



*Included in Nebraska Rule 10

Inquiry/Problem Solving

Inquiry/problem-solving skills help students become critical thinkers, self-directed learners, and productive consumers. During the K-12 experience, students should encounter diverse and complex types of problems that arise from both the real-world and mathematical and scientific contexts. As students progress, their problem-solving skills should increase and their problem-solving strategies should become more sophisticated. These skills and strategies will help prepare students to meet the challenges of an ever-changing world.

The process of inquiry/problem solving is infused throughout the Nebraska Mathematics/Science Framework document and is exemplified in the instructional models. Students are given ample opportunities in the instructional models to ask questions and to design investigations to answer questions that are meaningful to them. Students are to use their current knowledge to explore and pursue answers to their questions. This involves observation, the collection and analysis of data, discussion, and presentation.

The process skills of learning used throughout the Nebraska Mathematics/Science Framework document have provided a means to connect mathematics and science. The identification of the process skills common to both mathematics and science helps teachers identify the skills that need to be experienced and practiced if students are to master inquiry/problem solving.

What is Inquiry/Problem Solving?

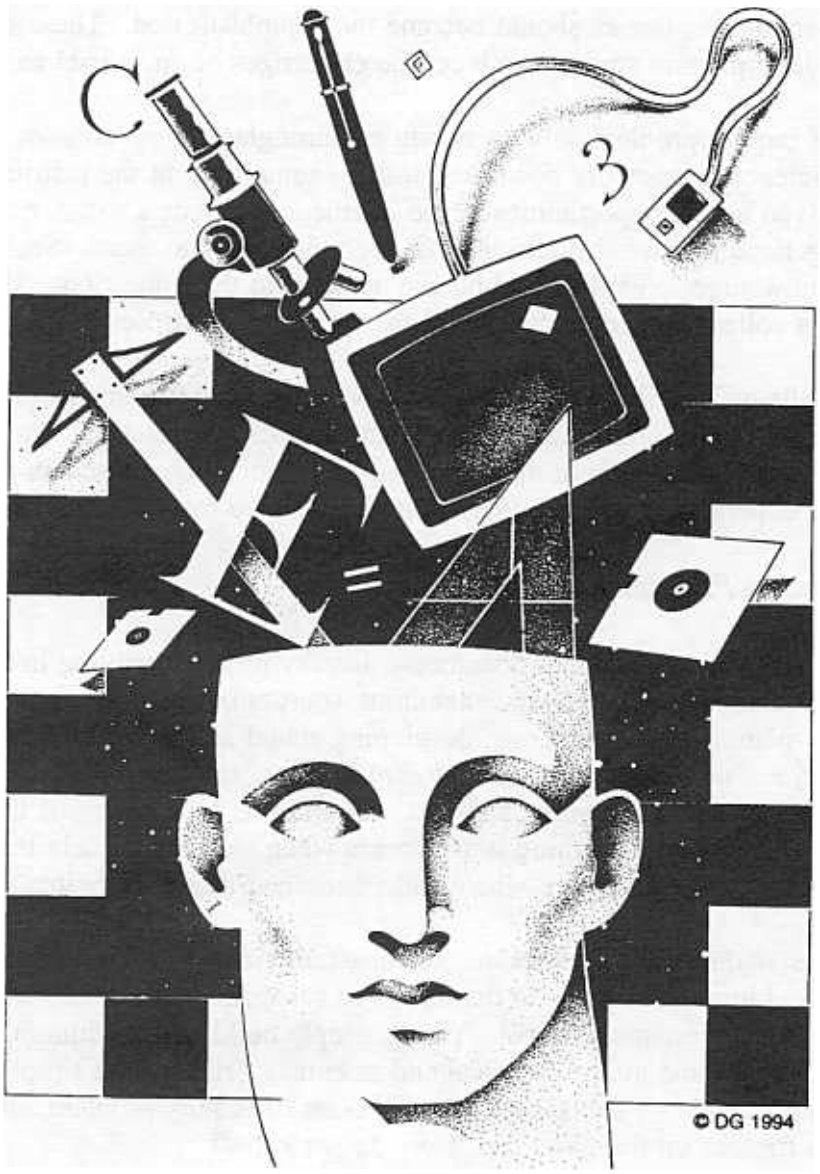
According to the national standards documents, inquiry/problem solving involves making careful observations, posing questions, examining sources of information to see what is already known, planning investigations, developing sound and coherent predictions, making thoughtful analyses, proposing answers and explanations, and communicating results. A key component is the interactions among students, in particular the sharing of thoughts and problem-solving strategies. Learning often occurs when students explain their ideas in ways that their peers will understand and when students defend their viewpoints.

Inquiry involves students in the processes scientists and mathematicians use to obtain and evaluate data, and introduces them to the nature of scientific/mathematic investigations as a means to understand the natural world. Young people build critical-thinking skills when they are encouraged to become mathematicians and scientists - rather than simply studying about mathematics and science - by modeling the processes of inquiry/problem solving, and when the exploration focuses on the question, "How do we know?"

The purpose of problem solving/inquiry is to motivate students to learn and to provide real world context for examining issues. As students investigate their own interests and make connections between their experiences and those of the larger community, they realize that learning is an extremely valuable process.

Teachers need to provide opportunities for students to "do" science and mathematics — to design and conduct experiments, to identify and solve problems, to participate in hands-on

activities, to ask questions, and to discuss and reflect on their findings. Instructional methods that support inquiry/problem solving include asking open-ended questions, sharing problem-solving strategies, and encouraging student interactions. Hands-on inquiry-based activities are included in the addendum.



Multicultural Perspective

Multiculturalism is a positive facet of life in Nebraska. Many science and mathematic educators have different ideas about what multicultural education is and what it means to teach multiculturally. Educators need to expose students to a broad range of experiences, cultures, and perspectives. Knowledge of the culture, history, and the contributions of groups that make up the population of Nebraska and other parts of the country and world will foster respect for diversity and provide for improved interrelationships among individuals.

Multicultural education has many dimensions: community involvement, student performance, educator performance, learning environment, and policymakers. The diagram on page L – 13 illustrates these dimensions.

School is a Reflection of the Community

The school is a reflection of the community including its ethnic, religious, and social values Multicultural education emphasizes education that promotes the strengths and values of the community. Families and communities can help educators understand and appreciate the cultural richness of their population. Multicultural education presents a challenge and an opportunity for community members to work together with schools to educate students.

Student Performance

Diversity has been a part of our country since its beginning. Multicultural education enables students to understand our country's racial, ethnic, and ancestral backgrounds. Infusing contributions and perspectives of many diverse groups into the curriculum helps prepare students to live, learn, and work in a pluralistic world.

Students need to develop a respect for different viewpoints, good listening and communication skills, and the ability to reason and share ideas with others. Students also need to apply their knowledge and skills to problems and investigations of local and global significance. They must understand that the world is very different from their own community.

Educator Performance

Teachers need to know their students and respect their diversity. Successful educators are able to meaningfully interact with students whose cultures are different from their own. A variety of student-learning styles requires teachers to use diverse instructional strategies. Teachers need to have the capacity to instruct students from a variety of backgrounds; hold high expectations for all students; and be prepared to use appropriate instructional and assessment strategies and materials that will optimize learning for all students. Of paramount importance is the belief that all children are able to learn and do quality science and mathematics.

Learning Environment: A Closer Look at a Multicultural Classroom

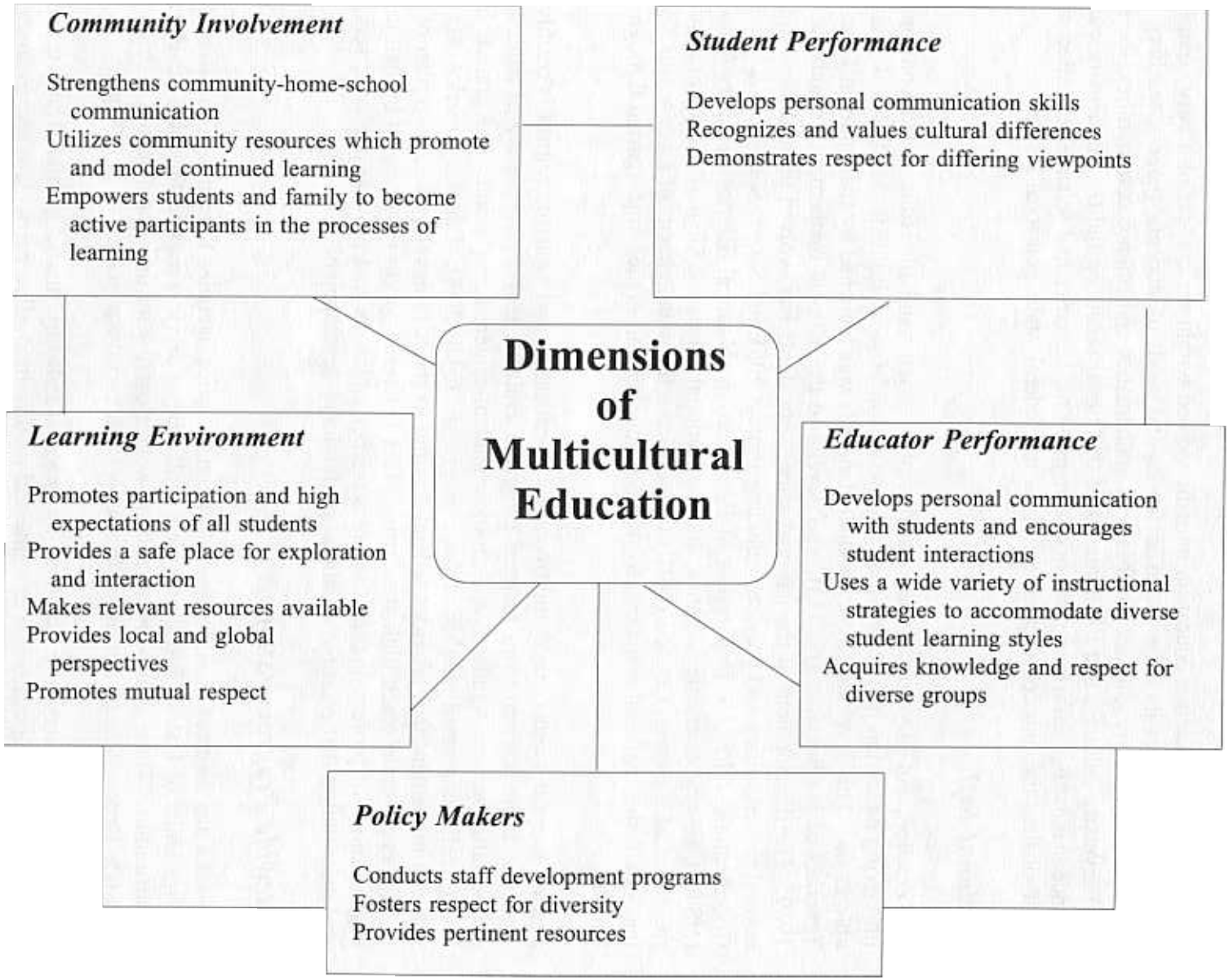
An observer in a multicultural classroom would see students grouped heterogeneously learning mathematics and science. In this setting, active students think and talk about mathematics and science with each other while respecting one another's viewpoint. Issue-oriented instruction would be used to promote authentic investigations and interactions among students. These students would be doing mathematics/science in the classroom, in the school yard, on nature trails, and at home as they puzzle over some of the wonders in their world.

Students would be connecting what is happening in the classroom to what is happening in their communities and the world. Teachers would be communicating with all their students and creating an environment in which all students feel comfortable interacting with the educator and other classmates. A variety of instructional strategies such as cooperative learning, the learning cycle, concept mapping, modeling, technology, role playing and simulations, storytelling, and use of investigations, community resources, and reflective thinking would be infused throughout the curriculum. The curriculum would reflect the experiences, cultures, and perspectives of a range of cultural, ethnic, and racial groups.

Policymakers

In 1992, the Nebraska Legislature passed LB 922, a legislative bill that requires all public schools to infuse multicultural education into the K-12 curriculum. The law is intended to promote cultural appreciation, awareness, and sensitivity in students to better prepare them to function in the next century. It is the responsibility of local school districts to provide quality professional-development programs and resources to enhance education for all students.

Multicultural education is a strategy that promotes the strengths and values of diversity. We are challenged to consider how schools can incorporate students' cultural differences and values, while ensuring quality education for all. Nebraska's schools and communities need to play an active role in celebrating our nation's diversity.


Community Involvement
Strengthens community-home-school communication
Utilizes community resources which promote and model continued learning
Empowers students and family to become active participants in the processes of learning
Student Performance
Develops personal communication skills
Recognizes and values cultural differences
Demonstrates respect for differing viewpoints
Dimensions of Multicultural Education
Learning Environment
Promotes participation and high expectations of all students
Provides a safe place for exploration and interaction
Makes relevant resources available
Provides local and global perspectives
Promotes mutual respect
Educator Performance
Develops personal communication with students and encourages student interactions
Uses a wide variety of instructional strategies to accommodate diverse student learning styles
Acquires knowledge and respect for diverse groups
Policy Makers
Conducts staff development programs
Fosters respect for diversity
Provides pertinent resources

The Big Picture

Mathematics and science education must be viewed within the context of a very complex system. The system includes the expectations and needs of students, parents, teachers, business and industry, and the professional mathematics and science communities; the school and university cultures; and the demands of traditional practices and the mathematics and science standards. Efforts to continually improve mathematics and science education are best accomplished through coordinated efforts at the federal, state, and local levels.

National Influence

The development of voluntary national discipline-based standards is the foundation for improving education by providing a common vision of what students should know and be able to do. The development of national standards was launched by the National Council of Teachers of Mathematics (NCTM), who developed the national mathematics standards in 1989. The development of the national science standards has evolved through the efforts of several organizations and projects including Project 2061 and Scope, Sequence, & Coordination. The U.S. Department of Education, the National Science Teachers Association (NSTA), several scientific societies, and the National Education Goals Panel commissioned the National Research Council (NRC) to coordinate the development of a consensus document that establishes national standards for science education in grades kindergarten through twelve.

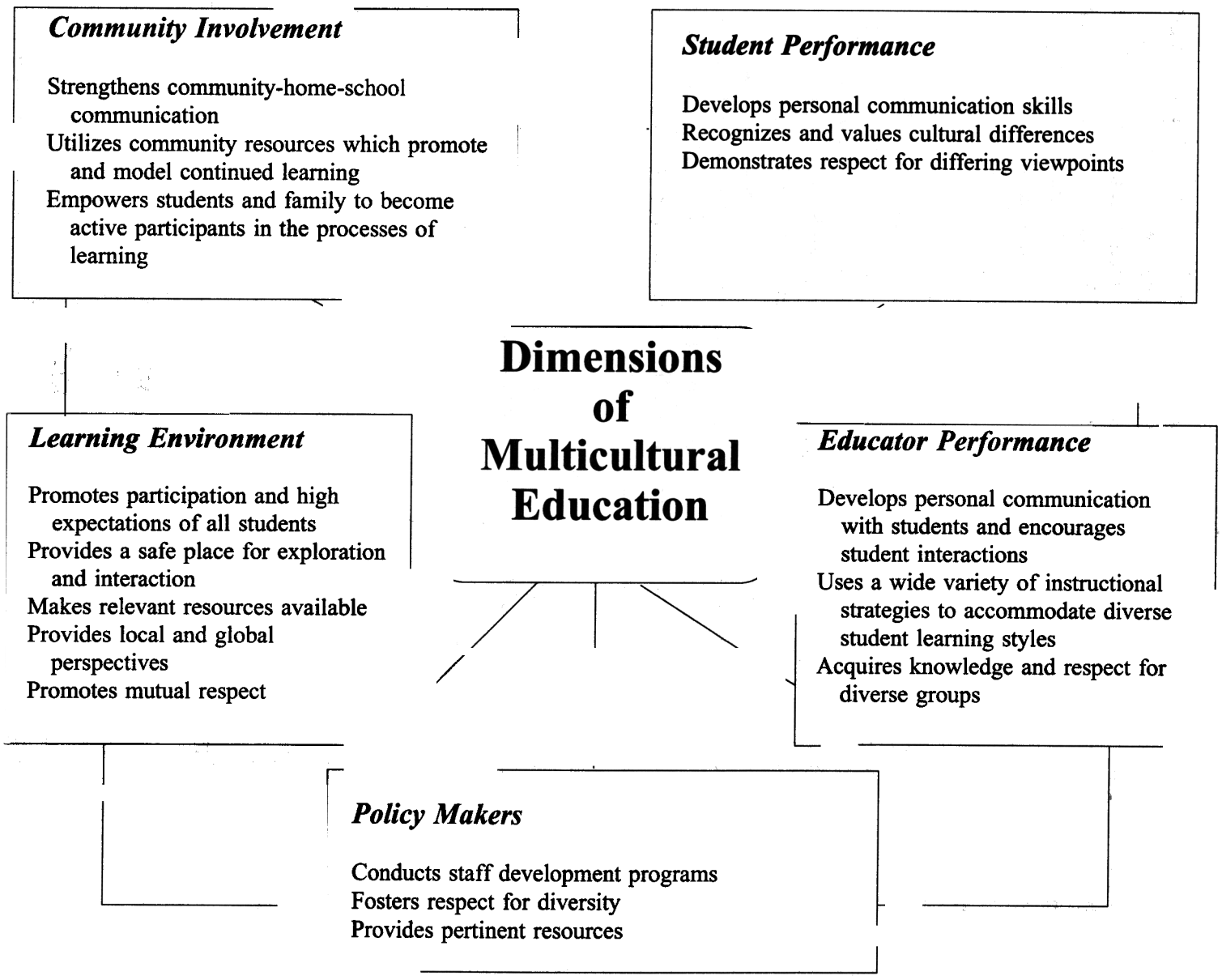
Federal support to encourage improvements in education and systemic reform is readily evident. There are numerous national programs available that are supportive of national mathematics/science standards and promote student-centered instruction. The graphic on page L – 17 reflects a small number of these programs. Goals 2000: Educate America Act is a national movement that provides federal funding to states to develop their own plan of action to help every child reach high standards. This federal support is augmented by national organizations of professional mathematics/science educators that provide products, services, and information that promote continual professional development.

Statewide Programs/Support

Nebraska has nineteen intermediate educational service agencies known as Educational Service Units or ESUs. ESUs provide a multitude of services and professional development opportunities. These multi-county entities work closely with their local school districts and the State Department of Education to support and encourage school-level change.

Over the years Nebraska has secured a number of federally funded grants. These grants have allowed Nebraska educators to examine and modify innovative curriculum and instruction in mathematics and science to fit the needs and resources of Nebraska's classrooms.

The Nebraska Mathematics/Science Initiative (NMSI) is funded by the National Science Foundation and will continue at least through September, 1997. NMSI funding currently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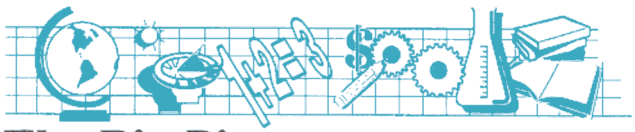

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supports the development of distance-learning efforts including Math Vantage and Practical Pre-College Mathematics (PPCM). NMSI has helped create seven regional mathematics/science coalitions across the state to build community-based support for mathematics and science education. NMSI also coordinates a professional-development program through the PEERS Academy, a peer-taught two-week workshop that encourages teachers to collaborate with one another to enhance mathematics and science instruction.

State efforts to improve mathematics/science education is enhanced by state professional organizations. Nebraska Association of Teachers of Science and Nebraska Association of Teachers of Mathematics are state professional organizations that coordinate annual conferences and offer the opportunity for teachers to interact and collaborate with one another.

Role of Nebraska Department of Education

The elected State Board of Education has the leadership responsibility to address the policy issues regarding quality education for all students in Nebraska, with the best-practice issues being the responsibility of the professional staff in the Nebraska Department of Education. On occasion, the legislature enacts into law statutes that address quality-education issues. The role of the Department of Education is to implement the intent of the law and/or promulgate rules and regulations which serve the interest of Nebraska students best.

Teacher certification and recertification are coordinated through the State Department of Education. Ad hoc committees are routinely formed to review existing teacher certification requirements in a five year cycle. The Mathematics Ad Hoc Committee has recently revised the requirements for a field endorsement in mathematics. The members of the committee and the revised requirements are found in the appendix. The Natural Sciences Ad Hoc Committee is in the process of revising requirements for teaching secondary science. Committee members involved in this process are listed in the appendix.

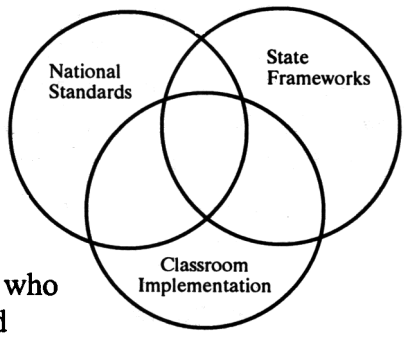
Professional-development activities and projects to enhance mathematics and science education are supported by Eisenhower funds, which are coordinated through the State Department of Education. The majority of the Eisenhower dollars are distributed to local school districts to support district curriculum plans/staff development.

One of the goals of the Nebraska Department of Education is to develop frameworks in each of the curriculum areas. State frameworks translate the national standards into classroom practice and provide models of best practices. The emphasis of the Nebraska Mathematics/Science Frameworks is on clear expectations of what all students should know and be able to do. The Mathematics/Science Framework Project is a major step toward beginning the process of consensus building to produce a common vision of mathematics/science education. The process to develop state frameworks promotes collaboration among students, parents, community, and educators in an effort to improve mathematics/science instruction and learning.

Summary

The national standards have provided the foundation that has given direction to states as they have undergone the process of creating state frameworks. The state frameworks provide the needed guidance to transfer the national standards into actual classroom practice.

It is hoped that this will be an interactive process with practicing teachers influencing state frameworks and national standards and state frameworks impacting national standards and classroom practice.



The chart on page L – 17 shows some of the many components which interact to provide quality schools and education for all Nebraskans. The focal point is the student who is located in the classroom of the local school district. Good classroom teachers need to become proficient at using the national standards, national programs, state programs, and the Nebraska Department of Education to create the best learning environment for their students. National standards, national programs, and state programs influence each other, increase resources available, and provide ideas which enhance the educational environment students will experience.

The model activities which are included in this addendum are based on the national standards and state frameworks. These model activities were developed and piloted to aid in the process of implementing frameworks into classroom practice. Concept webbing was used to connect the mathematics/science-oriented activities to other subject areas and to the community. Community connections have been developed to create relevant learning situations for students. The resulting instructional models are student centered, interactive, participatory, and fun. Not only do they cross traditional disciplines, but they also include academic and cognitive challenges at many levels. These instructional models exemplify the type of learning that students in our state should experience.

The national standards movement presents teacher educators an opportunity and obligation to examine pre-service programs and implement changes needed to reflect the vision of the standards documents. This is an excellent opportunity for content departments and teacher education departments to collaborate and jointly design improved courses and programs. Nebraska postsecondary educators have met the challenge to examine, rethink, and offer suggestions for revising existing teacher preservice programs. The resulting document, *Guidelines for Teacher Preparation: Mathematics and Science*, is available by contacting Monty Fickel at Chadron State College or Carol Mitchell at University of Nebraska at Omaha. In order for the current reform effort to be successful, it must be a K-16 endeavor with all parties actively participating.

The Big Picture